Assin.; 21st, Swift Current, Assin., and Battleford, Sask.; 22d, Qu'Appelle, Assin., and Battleford, Sask.; 23d, Minnedosa, Man., and Medicine Hat, Assin.; 24th, Minnedosa, Man., Medicine Hat, Assin., and Prince Albert, Sask.; 27th, Kingston, Ont.; 29th and 30th, Minnedosa, Man.; 31st, Quebec, Que., and Minnedosa, Man.

METEOROLOGY AND MAGNETISM.

The movements of our atmosphere are to be studied primarily as problems in the mechanics and thermodynamics of moving gases and vapors, but our knowledge of the empirical relations between atmospheric phenomena and terrestrial magnetism has been elucidated by a few special students, and further study in this direction has been recognized by the Chief of the Weather Bureau as proper and desirable. As the subject of atmospheric electricity, including that of auroras and earth currents, has a small section in this REVIEW, Professor Bigelow contributes the following section on terrestrial magnetism.

THE COMPARISON OF TEMPERATURE WITH MAGNETIC HORIZONTAL FORCE.

By Prof. F. H. BIGELOW.

The columns headed Calgary, Williston, and Sioux City give for each day, respectively, the mean of the 8 a. m. and 8 p. m. observations of temperature at the following groups of stations:

Calgary for Minnedosa, Qu'Appelle, Prince Albert, Swift Current, Medicine Hat, Battleford, Edmonton, Calgary.

Williston for Valentine, Yankton, Huron, Pierre, Moorhead, Bismarck, Williston.

Sioux City for Springfield, Mo., Kansas City, Wichita, Concordia, Omaha, Sioux City.

The average temperature for each group is reduced back to the origin, W. 115°, N. 55°, by a correction for eastward drift (see Amer. Jour. Sci., Dec., 1894). The first differences of these numbers are taken; then the monthly mean of the first differences for slope; then the variations on the slope; then these latter are added successively throughout the month and the accumulated sums give the ordinates of the curve for each group; the mean of these three groups is taken and gives the curve in the upper part of Chart V; the monthly mean of the ordinates is added with reverse sign to reduce to a true datum line. Thus, the eastward drift and the slope have been eliminated, and the variations reduced to a zero base line.

The magnetic data are treated in the same way as the temperatures. The curve as plotted is the mean of the ordinates of the three stations. It has been found that at least five magnetic observations are required to eliminate local conditions and to give a true value of the external impressed field, though seven are better. By inspecting the columns it will be seen that local variations disturb the curves in certain cases. Hence, as the data now exist, the comparison can give only partially accurate curves as to detail, though the main features may be expected to appear.

SPECIAL FEATURES OF THE JANUARY CURVES.

The temperatures of the Calgary group need the correction +1 for slope; the others are uncorrected. San Antonio is reduced for amplitude by the factor $\frac{1}{2}$; the others are unchanged. The mean temperatures are reduced to a zero datum line by +1, and the mean magnetic force by +23.

The new magnetic ephemeris, with the epoch June 13.72, 1887, went into effect on January 1, 1895 (see Am. Met. Jour., Jan., 1895). This is a change from June 12.22 for the epoch of the 26.68 day period, to conform to the position of the solar axis of the magnetic curve. The new period, therefore, begins on January 17.44. No magnetic disturbances were reported in January, 1895.

STATE WEATHER SERVICES.

The following extracts are given in regard to the general weather conditions experienced in the several States and Territories as reported by State Weather Service Directors:

Alabama.—January, which on an average is the coldest month of the year in this State, has been a typically wintry month, with many changes from daily normals for temperature and an excess of about 2 inches in rainfall. Three distinct cold waves passed over the State; one, on the 13th, brought very low temperatures all over the State, and high westerly winds prevailed on the 12th, 13th, 15th, and 26th.

Arizona.—The average temperature for the Territory, as deduced from the records of 36 stations, was 43.2°, or about 5° above the normal. The average precipitation, as deduced from the records of 44 stations, was 2.49 inches, which is about 1.50 inches above the normal.

Arkansas.—The monthly mean temperature for the current month was 3.3° below the normal. There were three distinct periods of abnormally low daily mean temperatures, viz, 1st to 4th, inclusive, about 8° per day below the normal; 12th to 14th, 15° below the normal, and 26th to end of month, 16° below the normal. The warm periods were 5th to 7th, 14° per day above the normal, and the highest temperature for the month was recorded at many stations; 18th to 23d, about 10°.

California.—The deficiency in temperature has caused no damage from frost, nor has the excessive precipitation done any material damage, excepting the flooding of some valuable lands along the Sacramento River, which will be planted to crops later on in the season.

Colorado.—The average temperature for the State was about 2° above the January normal. The fall of snow was most general on the 15th and 31st.

Florida.—The mean temperature for the month was about 2.2° lower than the mean for January, 1894.

Georgia.—The month opened with very cold weather prevailing, and on the 13th the State was again visited by a cold wave of marked severity, causing the mercury to fall to near zero at points in the northern districts, and far below the freezing point in the most southerly counties. The average temperature of the month, as a whole, however, varied but little from the normal. In the most northerly counties snow fell at quite a number of stations on the morning of the 12th, and again on the 28th and 30th, in the extreme northern sections only.

Idaho.—Snow fell over the greater portion of the State from the 8th to 13th and from the 16th to 23d. The cold periods were on the 7th and 8th and from the 25th to 31st. The monthly mean temperature for the State was 1.7° below that of January of last year.

Illinois.—The month was cold and stormy; snowstorms, with high winds, following each other in quick succession, and the intervals between storms were marked by sudden and severe cold waves. The month, although severe, was not greatly below the normal temperature, and was by no means the most severe on record. Five periods of severe cold are distinctly noted, viz, 4–5th, 8–9th, 11–14th, 23d–24th, 27th–31st. But one period of warmth is worthy of special mention, that of the week from the 15th to the evening of the 21st, although in southern counties the 6th and 7th were marked by high temperatures, in many cases the highest of the month.

The snow covering the State was generally sufficient to afford light protection to winter grain until the warm weather of the 18–20th, when it practically disappeared. Though the ground was exposed to the cold wave of the 23d–24th, a good mantle of snow again afforded protection from the very severe weather of the 27th to 31st. It is thought that grain has thus far escaped material injury.

Indiana.—The month was a cold one; the temperature was above the normal only 9 days, uninterruptedly so from the 15th to the 21st. The average temperature for the State was 2.9° below the January normal, and a deficiency in average temperature is noted in all portions of the State.

The heavy snowfall on the night of the 11th, during exceedingly low temperature and high west and northwest winds, was found to be

covered by a brown dust in many localities on the morning of the 12th. Many ideas as to its origin have been advanced.

Snow covered the fields more or less during the month and protected wheat and grass, and both were in good condition at the end of the month. In some localities peaches are reported to be injured by the low temperatures.

Iowa.—The current month was colder than the average with less than the normal amount of precipitation. Six cold waves of considerable severity swept across the State during the month, giving greater than the usual extremes of temperature.

Kansas.—January was a cold month, the temperature being generally below the normal. The warmest day was the 20th, the coldest day in the eastern half of the State occurred on the 12th, in the western half it occurred at the end of the month. Snowfall was below the normal over the entire eastern half, but above in the rest of the State.

Kentucky.—The normal temperature for the current month, as deduced from the records of the Weather Bureau stations at Cairo, Cincinnati, Lexington, and Louisville, covering periods of from twelve to twenty-three years, is 33°, which is about 3° in excess of that for the past January. The month was characterized by a cold wave of exceptional severity, which occurred on the 12th and 13th, and the fact that snow covered the ground throughout the State during the entire period from the 1st to the 31st. These conditions are considered as being highly favorable to agricultural interests. Precipitation, mainly in the form of snow, was about 1.50 inches in excess of the average.

Louisiana.—The weather during the current month was slightly colder than in a normal January, being about 1.5° below the normal mean temperature. The precipitation averaged very nearly the normal January fall, being slightly deficient in north Louisiana and slightly in excess in south Louisiana.

Maryland.—Three storms passed over the State during the current month, the most severe being that of the 26th. The monthly mean temperature was 3.4° below the normal. Precipitation 1.09 above the normal. The greatest fall of snow during the month, 56 inches, was reported by the observer at Oakland.

Michigan.—But two stations in the entire State have a mean monthly temperature above the normal, viz, Marquette and Alpena; at all other stations it was below. The 28th was the coldest day, the mean temperature of the State being 4°, and the temperature at almost every station falling below zero, while the maximum temperature for the day averaged less than 10°. The average precipitation was 0.77 above the normal. The average snowfall was quite heavy, 25.8 inches.

Minnesota.—The monthly mean for the State, as determined from 62 stations, was 2.3° colder than usual. During the first half of the month the temperature averaged about normal. A warm spell, averaging daily 12° above the normal, prevailed from the 14th to 21st. This was immediately followed by a decided change to colder, lasting throughout the remainder of the month, and with temperatures averaging daily about 10° below the normal. On the 5th and 6th from one to six inches of snow fell throughout the State, and the ground remained amply protected thereafter. From an agricultural point of view the weather was as favorable as could be wished for.

Mississippi.—The current month was cloudy, cold, and wet in this State, there having been a decided deficiency in temperature and a moderate excess of precipitation, as compared with the normal record of these conditions. There were two warm periods, viz, 6–7th and 16–20th, and two cold, viz, 1st, 12–13th. Three distinct snowstorm periods were observed: The first, on the 1st and 2d, was confined to the northern stations; the second lasted from the 8th to the 10th and was felt in all sections except the extreme southwest; the third prevailed from the 27th to the 29th but did not extend below the central counties.

Missouri.—The most prominent features of the current month were the cold wave which passed over the State on the 12th, the unusually warm weather from the 18th to the 21st, and the heavy snows and low temperature of the last seven days. On the 2d and 3d snow fell in the southern portion of the State to a depth of from 1 to 8 inches, and on the 25th and 26th heavy snow was general, except in the southeast section, drifting badly in some localities. From the 26th to the close of the month the temperature was much below the normal. Up to the 25th winter wheat had but little protection, but at the close of the month the ground was covered with snow over the greater portion of the State. Water for stock continues very scarce in many localities.

Montana.—The temperature for the current month was about 4° below the normal. The precipitation was about 0.35 of an inch above. The coldest weather during the month occurred on the 27th, and the warmest on the 12th and 13th.

Nevada.—The mean temperature for the State was 1.2° below the normal. The precipitation was 0.82 above the 8-year normal. The greatest snowfall, 93.0 inches, occurred at Marlette Lake, and the least, 2.0 inches, at Downeyville.

Nebraska.—The month was very nearly a normal one with a mean temperature of 18.9°, which is one-tenth of a degree warmer than the average for the past sixteen years.

The average snowfall for the State was about 4 inches, representing 0.39 inch of precipitation, or about half the normal amount.

New England.—There were no great extremes in temperature during the month, but the weather was characterized by generally steady disagreeable conditions. Nine cyclones and the same number of anticyclones influenced the weather in this section. About the usual amount of snow fell in the southern districts, but it was less than normal in the north. Probably no injury has been done to grass or grain roots, and the temperature has not been low enough to damage fruit trees.

New Jersey.—The mean temperature for the State was 1.4° below the normal for the month. Precipitation 0.78 inch above the normal. A great quantity of snow fell, the ground being covered much of the time.

New Mexico.—The temperature throughout the month averaged about normal. Thirteen stations reported a minimum below zero. The precipitation was much above the normal and quite unevenly distributed. The greatest total snowfall was 53 inches at Chama, and the least was a trace at Springer.

(A State Weather Service in this Territory has lately been established by the Legislature.)

New York.—Both pressure and temperature were below the normal, but the month does not rank among the very cold Januaries shown by the records of this State. Cold weather prevailed from the 1st to the 6th, the lowest temperature of the month occurring on the 5th. The period included between the 6th and the 18th was for the most part slightly warmer than the normal, as were, also, the 21st and 22d, after which the weather continued cold until the close of the month. The highest temperature obtained on the 7th and 11th, when the maxima exceeded 50° in the coast region.

The total precipitation, while generally above the normal, was noticeably deficient in portions of the central and eastern sections. The only notably heavy rain or snowfall occurred on the 26th.

North Dakota.—The month of January, just closed, was a severe one even for this latitude, and was remarkable for its long-continued cold periods. While the extremes of temperature of former years have not been reached, yet the mean temperature averaged 2° lower than the normal or mean for many years past.

The snowfall was lighter than usual, although the number of days on which it fell was nearly double the usual number, but, owing to the absence of high winds, it did not drift badly, and the amount on the ground at the close of the month was much nearer the average than has been for some years past.

North Carolina.—The month of January was a very wet, cold, and altogether disagreeable month. The weather was influenced by an unusually large number of low areas, many of which passed south of the State or lingered on the south Atlantic coast. The temperature was below normal on about seventeen days during the month, the greatest departures occurring on the 13th and 14th, during the prevalence of a severe cold wave. The warmest periods during the month were 6th, 7th, 8th, 16th to 19th inclusive, and 21st to 24th. The coldest day everywhere was the 13th, except in the southeast, where it occurred on the 1st, the effect of the last cold wave of December, 1894.

The average precipitation was 1.89 inches above the normal, the greatest departure occurring in the central district, where the average exceeded the normal by 2.70 inches.

Ohio.—The mean temperature was below the average. The heaviest fall of snow occurred from the 10th to the 13th, and averaged 8.1 inches for the State, falling in advance of the severe cold of the 12th and 13th, it afforded excellent protection to the winter cereals. The light snowfall during the latter portion of the month was not sufficient to give much protection, and as a result the cold wave following proved injurious to the winter cereals.

Oklahoma.—Average temperature, 1.5° below the normal, and precipitation 0.52 below. Farmers generally concede that the prospect for anything like an average wheat crop is anything but encouraging, and the majority think there will be no crop at all. Many fields planted late never sprouted at all and the earlier fields came up, but the subsequent drought destroyed nearly all the roots.

Oregon.—A nearly normal temperature, unusually copious rain and snow fall, and a remarkably severe sleetstorm were the chief characteristics of the weather that prevailed in Oregon during January, 1895.

There was an excess of precipitation in all sections of the State, especially in the Willamette Valley and the coast section. No such precipitation as this month's has occurred in the Willamette Valley in six years. The average for the whole State was 9.45 inches, or 2.99 inches above the normal.

Pennsylvania.—The average temperature for the month was 4.4° below the average of the past seven years, and the average precipitation was 0.70 more than the average for the last seven years.

South Carolina.—The month has been about 2° colder than the average. There was one cold wave of unusual severity which gave below zero temperatures in the mountains of the western portion of the State on the 13th, and in other portions the temperature fell to, or below, previously recorded low readings for the same month. There was more than the average rainfall, the excess being 3.00 inches, or 166 per cent of the normal. This delayed plowing and other farm work incidental to the season in this State. In the low counties the swamps and lowlands were filled with water, and many roads became almost impassable for vehicles. The severe cold weather, it is reported, greatly injured fall-sown oats, but did little injury to wheat and rye.

South Dakota.—With the exception of three or four days, the first and second decades of the month were comparatively mild, but the third decade was marked by continued and steady cold weather, although the extremes of cold were not as great as usual. The average depth of the snow on the ground on the 15th was 1.6 inch, and on the last day of the month, 3.00.

Tennessee.—This has been a rather cold, wet month. The temperature averaged about 2° below the normal during the entire month, while there were but six days on which there was no precipitation. The most severe cold of the month reached us on the night of the 11th, reducing the temperature to from 1° above zero in the western portion of the State to 15° below zero in the northeastern portion. With one exception, 1892, the month averaged colder than any January since 1886.

The cold weather has caused much suffering among stock, but on the whole has been beneficial to the farmer, keeping back vegetation, etc. Wheat has been protected by a covering of snow and is said to be in excellent condition. The sap has been kept down in fruit trees, and if these conditions continue until the opening of spring we may expect a good crop and fruit yield throughout the State.

Texas.—The temperature on an average for the State was 1.5° above the normal. Several light northers crossed the State during the month, and two severe ones were experienced. The coldest weather over the southern portion of the State prevailed about the 10th of the month, when the temperature fell to about freezing or slightly below, while the lowest temperatures over the northern and central portions were reported between the 28th and 31st, inclusive.

The precipitation on an average for the State was 1.16 inch below the normal. The rainfall was not well distributed during the month, and was hardly sufficient for farming interests, except over the northeastern portions of the State, where a heavy rainfall was experienced.

Utah.—The first half of the month was comparatively mild and pleasant, with temperatures generally above the normal. During the last half the weather was more or less stormy at intervals, with a severe cold wave on the 28th, which caused the lowest temperatures recorded during the month.

Virginia.—The temperatures averaged slightly below the normal in the tidewater sections, while the deficiency increased to the westward. The total amount of precipitation averaged about or very slightly above the normal near the coast and from 50 to 75 per cent above the normal in the other sections, with more than the average amount of snowfall. The snowfall proved generally beneficial to winter wheat, oats, etc.; especially in the northern and western sections of the State.

Washington.—It appears to be the impression of a great many that the weather thus far this winter has been unusually mild in Washington. Such is not the case, and the current month had a mean temperature which was 1½° below the normal. There have been no extremely low temperatures, and, on the other hand, the maximum temperatures were not as high as in former years. In eastern Washington the lowest temperature at the coldest station was only 6° below zero. No violent storms passed over the State, although there were two rather severe ones, which swept the coast. The rainfall was well distributed throughout the month.

West Virginia.—The average temperature for the month was below normal. On the 12th the drop in temperature was phenomenal, the fall varying from 40° to 50° in less than twenty-four hours, and was accompanied by considerable snow. Snowfall was fairly distributed throughout the month.

Wisconsin.—The mean temperature for the month was 3.6° below the normal; precipitation 0.17 of an inch below the average for the month. A very severe storm entered the State from the southwest on the night of the 20th, and continued, with increasing force, during the 21st, passing off to the northeast on the evening of that day. Rain and sleet, accompanied by thunder and lightning, prevailed throughout the central and southern portions on the night of the 20th and early morning of the 21st. This was followed in the afternoon by a westerly gale, with a wind velocity of 50 miles per hour at Milwaukee, heavy snow, and zero temperatures. Another severe snowstorm occurred on the 25th, accompanied by high northeast gales, which drifted the falling snow and caused great inconvenience to railroads. This was followed by extreme cold weather, which continued to the close of the month. The cold was so severe that the ground froze to a great depth, and many complained of vegetables being frozen in the cellars.

Wyoming.—The mean temperature for the month was 20°, which was slightly lower than the average for January. The average amount of precipitation for the State was 0.95 of an inch, which was about one-third greater than the usual January precipitation.

STUDIES BY FORECAST OFFICIALS.

As a preliminary study to active forecast duty the officials of this division are given subjects for investigation from time to time. The following paper, prepared under the direction of Maj. H. H. C. Dunwoody, U. S. A., assigned as Acting Assistant Chief of Bureau, in charge of Forecast Division, is published with his consent.

TYPES OF STORMS IN JANUARY.

By E. B. GARRIOTT, Forecast Official.

Classified with reference to the regions in which they first appeared, the January storms traced in the MONTHLY WEATHER REVIEW during the last ten years fall under the following general heads:

Region in which storms first appeared.	Total number of storms in ten years.
Saskatchewan Valley	32
Southwestern States	21
North Pacific coast	20
Northeast Rocky Mountain slope	8
Middle-Western States	7
Ohio Valley and Tennessee	3
Southeastern States	2
South Pacific coast	0
Total number in ten years	94

About 80 per cent of these storms belonged to what may be termed three principal types. One type, which presented the greatest number, embraced storms that advanced from the Saskatchewan Valley; another included storms that first appeared in the Southwestern States, and the third storms which moved eastward from the North Pacific coast. The remaining storms, which were generally secondary developments to low areas of the three principal types named, were widely distributed, and while their relatively limited number will not justify their acceptance as independent types, the fact that they collectively composed one-fifth of the storms of the month, calls for a consideration of their characteristics as secondary types.

STORMS FROM THE SASKATCHEWAN VALLEY.

Chart 1 shows the tracks of all January storms that entered the region of observation north of Montana and North Dakota during the last ten years. Twenty-one, or fully two-thirds of these storms reached the Atlantic coast, and all but three of this number passed to sea north of the fortieth parallel. The plotted paths show that the usual path of storms of this general type is east-southeast over the Canadian Maritime Provinces, and it may be assumed that similar and well-marked weather and temperature changes and conditions will attend storms of seasonal severity and average speed that follow the average track. It may also be assumed that unusual and particularly notable changes and conditions will be presented in connection with storms that depart from the usual path. The principal problem in practical forecasting is to calculate the direction of movement, speed, and intensity of a storm at the time of its first appearance in a defined district. In the case of Saskatchewan Valley storms we know that two out of three of these storms pass east-southeast to the Atlantic coast north of the fortieth parallel, and that their average velocity is about 37 miles per hour. In discussing these storms, an effort will be made to connect their movements with the general distribution of pressure and temperature, and to point out those conditions which favor normal movements and the causes which seemed to occasion abnormal movements.

A storm remarkable both as regards its direction of movement and speed swept rapidly southeastward from Alberta to